FORUM

Taking Jack IN the Beanstalk

The emerging science called genomics has given farmers "magic" beans akin to those in the children's fable.

They won't grow into a mammoth beanstalk leading to a giant's castle and gold. But by 2007 they'll provide 2 billion pounds of soybean oil with a linolenic acid content so low that it won't need hydrogenation to extend shelf life. Hydrogenation creates the trans fats consumers are concerned about.

By 2009, the industry expects to be marketing soybean oil with higher oleic acid content to give it more monounsaturated fats, like olive oil has. And closely following these advances, soybeans will have more—and higher quality—protein as well as higher yields.

Our Soybean Genomics and Improvement Laboratory at Beltsville, Maryland, is part of an international effort among ARS, university, and industry scientists to map the soybean genome as a blueprint to use for improving this important crop and other legumes. The lab has found more than 1,500 special genetic markers right inside of—instead of only nearby—soybean genes. This will allow breeders to go straight to the regions of the genome in which the genes reside.

Improving soybean oil quality is a top priority of both industry and ARS researchers. The reason is simple: U.S. consumers buy about 17 billion pounds of soybean oil (in various food products) each year, and the trend in consumer preference is toward healthier diets. So soybean oil with greater levels of oleic acid is what a more health-conscious public wants.

But genomics researchers seek other improvements, too. For example, future soybeans will grow on plants that are more resistant to diseases and pests. The beans will also be less likely to cause allergic reactions. Genomics research offers these improvements and more, because it holds the keys to understanding life—down to its tiniest building blocks.

Thus, rather than increasing the size of the beanstalk, genomics is more like shrinking Jack himself, so he can peer inside his beans' innermost recesses to gain the gold of knowledge and hidden traits.

The view that genomics scientists are beginning to glimpse promises to be even more exciting than the biological revolution of the past several decades. For one thing, everything is getting smaller—from sample size to number of chemical reagents used. And as genomics technology develops alongside computer technology, vast amounts of genomic information can be stored on smaller chips and made available to researchers worldwide.

STEPHEN AUSMUS (D125-27)

Geneticist Niels Nielsen inspects soybean seeds, which were soaked in water to help them germinate, before planting them as experimental controls. See story on page 4.

Laser-capture microscopy allows scientists to get a good look at messenger RNA at work. The technique captures single cells so scientists can determine what gene is guiding the cell to make a protein that causes a trait. Other researchers at the Soybean Genomics and Improvement Laboratory are using this instrument to watch soybean cyst nematodes drink from soybean root cells. With it, they can zoom right to the action—to the very spot where a nematode's bite is triggering a reaction from a plant—to find out what genes these root cells use in self defense. These observations could reveal mechanisms involved in the pest attack and plant reaction—knowledge that could one day lead to engineering a plant that would resist the nematode, no matter how the pest evolved.

The science of genomics is increasingly homing in on the proteins genes produce to do their work. It's a branch of genomics called "proteomics." It supplements structural genomics, which searches for the chemical makeup of DNA, and functional genomics, which looks for the effects of a gene on an organism. A functional-genomics technique called TILLING is discussed in the article beginning on page 4.

To capitalize on genomics technology, the legume industry, funded by farmers, has formed the U.S. Legume Crop Genomics Initiative. It hopes to facilitate communication and cooperation among scientists interested in genomics research on soybeans, peanuts, peas and lentils, common beans, alfalfa, and other legume crops.

As part of this initiative, the American Oil Chemists' Society—a professional organization for researchers interested in the science and technology of fats and oils, such as those in soybeans—recently published a book titled "Legume Crop Genomics." ARS scientists wrote or co-authored 6 of its 19 chapters, and the agency made other contributions, including funding and seed-oil analyses. The book documents the latest research strategies, genomic tools and technologies, and goals of the legume research community. Copies may be ordered for $180 (member price: $162) from AOCS Press Orders, P.O. Box 3489, Champaign, IL 61826-3489, or at www.aocs.org/catalog (click on "Biology, Biotechnology" link).

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